FIRE HISTORY AND FIRE REGIMES

SOUTH FORK SALMON RIVER DRAINAGE, CENTRAL IDAHO

PAYETTE & BOISE NATIONAL FORESTS

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Stephen W. Barrett

Consulting Research Forester

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INTRODUCTION

This report describes historical fire regimes for the South Fork Salmon River drainage, Payette- and Boise National Forests, in central Idaho. The goal of the project was to supplement previous work (Barrett 1988) in determining drainage-wide fire regimes patterns, to help managers design strategies for ecosystem-based management. Specific objectives were to: 1) sample presettlement fire history, 2) model presettlement fire regimes, and 3) document the effects of attempted fire exclusion after 1900.

The South Fork watershed (2200-8900 ft. elev.) encompasses approximately 700,000 acres of relatively steep montane- and subalpine forests in central Idaho. Stands on southerly and easterly aspects at low- to middle elevations occur in the ponderosa pine-Douglas-fir cover type (i.e., warm-dry Douglas-fir- and grand fir habitat types [Steele et al. 1981]). Northerly aspects at low- to middle elevations support various combinations of western larch, Douglas-fir, and ponderosa pine (i.e., moderately warm-moderately dry grand fir habitat types). Forest cover types in the subalpine zone are lodgepole pine, lodgepole pine-Douglas-fir, spruce-fir, and whitebark pine (i.e., cool-dry and cool-moist subalpine fir habitat types).

METHODS

Because of the large size of the South Fork watershed, two sampling approaches were used to maximize both sampling efficiency and areal coverage. First, the 8000-acre Camp Creek subwatershed was sampled intensively, using a system of transects (Arno and Sneck 1977, Barrett and Arno 1988). This approach was used to obtain the most thorough interpretation possible

about the mix of historical fire regimes in a representative subwatershed. Subsequently, a less intensive approach was used in which 25 reconnaissance plots were located throughout representative portions of the South Fork drainage. That method was used to provide broader-scale landscape coverage, and to cross-check the representativeness of samples in the Camp Creek drainage.

The methods of Arno and Sneck (1977) and Barrett and Arno (1988) were used to sample fire history. Specifically, partial cross-sections were sawn from fire scarred trees, and an increment borer was used to sample fire-regenerated age classes along transects coursed through the Camp Creek study area, and at the reconnaissance plot locations. At each sample site, forest cover type and habitat type were documented in 375 m^2 circular plots. Successional trends were documented in the plots by estimating the canopy coverages of each tree species by four d.b.h. classes: 1) seedlings/saplings [0-4 in.], 2) poles [4-12 in.], 3) mature trees [12-30 in.], and 4) old growth trees [30+ in.].

The fire scar- and increment core samples were air-dried and sanded, then analyzed with a 10-20x binocular microscope. Fire year estimates were compiled into stand- and study area (i.e., Camp Creek) master fire chronologies (Romme 1980, Arno and Peterson 1983), as follows. Closely similar scar year estimates were adjusted to those obtained from nearby samples yielding the clearest ring counts. Then stand fire chronologies were produced by listing the estimated fire years and fire intervals for each site (Arno and Peterson 1983). Stand structure was determined by examining the piths of sample trees relative to the stand fire years, to assess whether the stands were even- or uneven aged. Subsequently, the fire year data were organized into a master fire chronology (Romme 1980) for the Camp Creek study area, enabling an analysis of coarse-scale

fire frequency.

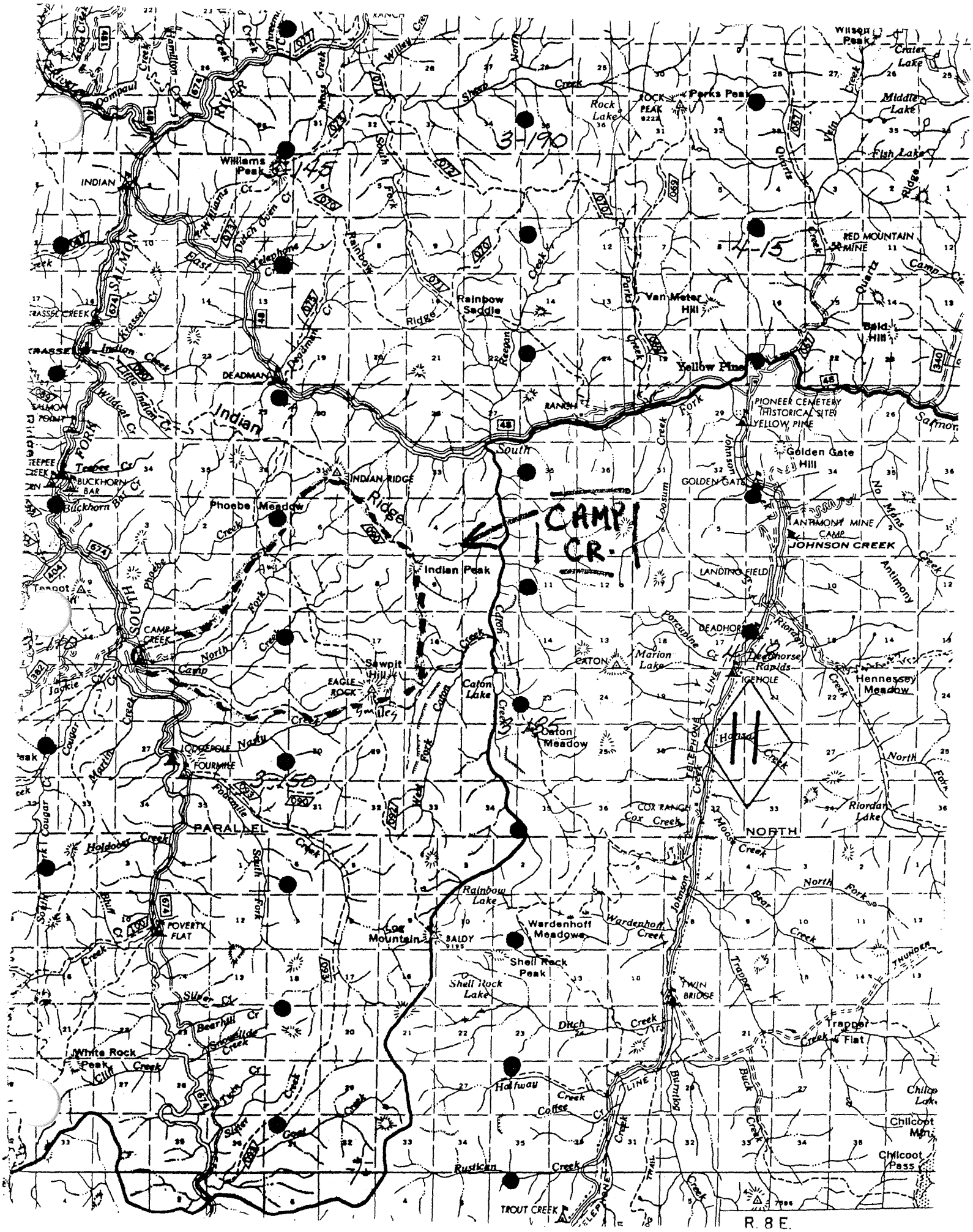
Fire frequency was analyzed for each sample stand, and for the entire Camp Creek study area, as follows. The fire year data were used to calculate: 1) mean fire interval [MFI], 2) fire interval range, and 3) number of years since the last fire. For planning purposes, the first two pieces of data above document the natural range of variability in presettlement fire frequency, for both the stand- and landscape scales. Conversely, the effectiveness of attempted fire exclusion after 1900 can often be measured by examining the years-since-last-fire data (i.e., current fire interval).

RESULTS AND DISCUSSION

Landscape Fire Patterns: Camp Creek Study Area. Sampling at 56 sites in the Camp Creek drainage produced 100 fire scar cross sections and increment cores from fire-regenerated age classes (fig. 1). These samples yielded an unusually long Master Fire Chronology, spanning the 528 years from 1471 to 1999 A.D. (Appendix). That is, area fire chronologies in the Northern Rockies rarely extend earlier than the 1600s, because recurrent fires destroy most prior tree ring evidence.

An estimated 70 fires occurred during the "natural" fire period, 1471 to 1948 (i.e., pre-effective fire suppression era). Those data yielded a mean fire interval of seven years for the study area (see enclosed Master Fire Chronology). That is, a spreading fire occurred in the 8000-acre drainage at least every seven years during the 5-century long period. Although an apparently natural fire occurred in the subalpine zone in 1992, only four moderate-size fires occurred during the 20th century. In comparison, an average of 10 or more moderate- to large size fires occurred

Figure 1. 1999 Camp Creek study area, Payette National Forest.


CAMP CR.
3N90
4N5
4N6
3N5
3N6
Williams Peak
Rock Lake
Rock Peak
Parks Peak
Wilson Peak
Crater Lake
Middle Lake
Fish Lake
Red Mountain Mine
Van Meter Hill
Rainbow Saddle
Yellow Pine
Bald Hill
Pioneer Cemetery (Historical Site) Yellow Pine
Golden Gate Hill
Golden Gate
Antimony Mine Camp
Johnson Creek
Landing Field
Deadhorse Rapids
Igehole
Hennessey Meadow
Indian Ridge
Phoebe Meadow
Indian Peak
Sawpit Hill
Eagle Rock
Caton Lake
Caton Meadow
Marion Lake
Eaton
Deadhorse
Cox Ranch
Cox Creek
North Fork
Riordan Lake
Rainbow Lake
Wardenhoff Meadows
Log Mountain
Baldy
Shell Rock Peak
Shell Rock Lake
Twin Bridge
Trapper Flat
Halfway
Coffee Cr
Rustican Creek
Trout Creek
Chilco Lake
Chilcoot Mtn
Chilcoot Pass
Lodgepole
Four Mile
Poverty Flat
White Rock Peak
Cliff Creek
Bearhill Cr
Snowslide Creek
Silver Cr
Holdaday Creek
Parallel
Buckhorn Bar
Teepee Creek
Tepee Cr
Wildcat Cr
Indian Cr
Deadman
Rainbow Creek
Parks Creek
Quartz Creek
Johnson Creek
Loosum Creek
Antimony Creek
Riordan Creek
Moose Creek
Trapper Creek
Buck Creek
Chilco Mtn
Salmon River
South Fork
North Fork
Middle Fork
Camp Creek
Jackie Cr
Cougar Cr
Martin Creek
Blue Cr
Slate Creek
Phoebe Creek
Caton Creek
Wye Fork
Hennessey Creek
Horse Creek
Telephone Cr
Blast Cr
Kissel Cr
Dutch Oven Cr
Threemile Cr
Willey Cr
Sheep Creek
Ditch Creek
Porcupine Cr
Thunder Creek
Bluffington
Elephant Back Trail
R. 8 E.

per century before 1900. This pattern suggests that post-1900 fire suppression effectively precluded many fires in the area, even though a few fires still occurred after that time.

Estimated intervals between the fires from 1471 to 1948 ranged from two to twenty-seven years long. However, these fire frequency estimates are likely conservative. Sampling cannot detect every small fire in a large study area, especially given the depletion of fire scar evidence over time (Arno 1976, Barrett and Arno 1982). Therefore, because nearly five decades passed between significant fires (i.e., 1948–1992), the fire-free interval was six times longer than the presettlement MFI for the entire study area. (Also note that two manager-ignited prescribed fires occurred in lower elevation stands in 1988 and 1998).

The fire frequency data suggest that factors such as early-day grazing and the decline of Indian burning (Gruell 1983, Gruell 1985, Arno and Gruell 1983, Arno and Gruell 1986) also may have affected fire frequency before the advent of organized fire suppression. The frequency curve declines steeply after 1900, with only one large fire occurring in about 1918. In contrast, three major fires occurred between just1882 and 1899, with the historic 1889 fire represented by the largest number of samples in the database. The year 1889 was the most severe drought year in the Columbia Basin between about 1670 and 1970 (Graumlich 1987), and likely the most widespread fire year in the Northern Rockies between 1500 A.D. and the present (Barrett et al. 1997).

Uniform fire frequency in the study area throughout both dry- and wet climatic periods (Karl and Koscielny 1982, Graumlich 1987, Meko et al. 1993, Barrett et al. 1997) suggests that presettlement fires may have been caused by both lightning and Indians (Barrett and Arno 1982, Gruell 1985). However, most fires since 1900 have been quickly suppressed at less than one-

quarter acre in size. Based on the presettlement fire frequency, as many as 20 natural fires might have been precluded from the drainage during the 20th Century as a result of effective fire exclusion. Importantly, however, several fires in recent years, including manager ignited fires, have been an important contributor in restoring natural fire regimes.

High presettlement fire frequency, and advancing forest succession during the early to late 20th Century, have largely obscured old burn margins. That is, portions of old burn mosaics are usually visible only on upper elevation, north-facing slopes occupied by even-age lodgepole pine. Based on plot locations, however, presettlement fires were often limited in extent, or, were light underburns that failed to scar many trees. For example, 73 percent of the fires in the chronology were recorded in six or fewer (<10%) of the sample plots, which were well distributed throughout the study area. Moderate to large size fires occurred an estimated 19 times between the late 1400s and 1948, that is, about 27 percent of the fires in the master fire chronology. (Note that the term "large fire" is used only in the context of the 8000-acre study area, which is smaller than many wildfires). Such fires, recorded in from 20 to 46 percent of the sample plots, averaged about every 27 years. The seven largest fires, such as in 1889, scarred from 36 to 49 percent of the plots and likely burned between 50 and 75 percent of the Camp Creek drainage. The large-fire MFI therefore was about 80 years between 1471 and 1948. Currently, the study area has not experienced a major fire in 82 years (i.e., since 1918). However, the occurrence of the 1992 wildfire, and of the two manager-ignited fires in the lower elevation portions of the drainage, could represent mitigating factors in terms of fuel hazard reduction in the drainage.

Unlike during an earlier study in the lower Salmon River drainage (Barrett 1998), area fire age classes were not mapped, for several reasons. First, the Camp Creek study area contains a

much larger amount of dry forest types, where developing detailed maps of past fires is largely infeasible. That is, fire mapping is generally not possible where nonlethal underburns were very frequent. By contrast, Barrett's (1998) sampling found that even age classes that had regenerated after relatively severe fires were more common in the higher elevation Papoose study area straddling the Salmon-Snake divide in the Hells Canyon Recreation Area. Because only the steepest north slopes in the Camp Creek study area contain one-age stands, the 8000-acre study area is too small in relation to most wildfires to yield meaningful interpretations.

Stand Fire Patterns: Camp Creek Study Area.

Ponderosa Pine. Fire scarred trees range from abundant to scarce on any given site, depending on forest type. For example, old growth ponderosa pine stands often contain multiple fire scars from recurrent short interval underburns. Conversely, upper elevation stands usually have only one or two scars and multiple fire-regenerated age classes from moderately long interval fires. These patterns initially suggested that nonlethal- and mixed severity fires (Barrett et al. 1991, Agee 1993, Quigley et al. 1996, Morgan et al. 1998, Barrett 2000), rather than long interval stand replacing fires, have been the predominant fire severity types in the South Fork drainage. In addition to the nonlethal fire regime, which occurs on most low- to mid elevation southerly aspects, two distinct mixed severity fire regimes were found in the study area. Specifically, different fire frequency- and severity patterns were found in moderately dry- versus subalpine types in the mixed regimes, as described below.

Plot sampling produced long-term data for 56 sites in the various fire regime types. Combining plot data into composite master fire chronologies subsequently produced data from 37

plot clusters (i.e., multiple plots in a given stand). First, data were obtained from 17 stands in the two high frequency/low severity fire regime types at low- to mid elevations (i.e., NL and MS_I fire regimes)(Table 1). Such stands typically are dominated by xeric ponderosa pine, or by ponderosa pine and Douglas-fir on mesic sites, including in lower elevation riparian zones. The stand fire chronologies often extended from the early 1600s to the present, during which time from eight to 30 fires occurred. In the nonlethal regime, 13 stands on the driest ponderosa pine habitat types, typically on low elevation southerly aspects, had a 12-year long average MFI. Individual fire intervals in the chronology ranged from one to 20 years long. One ponderosa pine sample tree on a dry lower elevation ridgeline is especially noteworthy in this regard. The tree has an estimated pith date of 1294 A.D., and a catface containing about 28 fire scars. Moreover, the tree ring release and suppression patterns in the chronology suggested that the tree may have been underburned as many as 45 times. However, because some of these events likely are growth responses due to shifting annual precipitation (e.g., drought years), the fires are not verifiable without associated scars.

Presettlement fires were somewhat less frequent, and slightly more severe, in the adjacent MS_I fire regime type for ponderosa pine/Douglas-fir stands. Specifically, MFIs generally ranged from 20 to 30 years long, with an overall MFI of 22 years. Such sites occur on low elevation north slopes, and in adjacent riparian zones.

In contrast to the presettlement fire frequency, during the fire exclusion period as many as five or six decades passed before the recent introduction of manager ignited prescribed fires. This translates into a fivefold increase in fire interval length in comparison with the historical MFIs. Additionally, because the prescribed burning generally did not include riparian zones, those stands

Table 1. Fire regimes data from 17 stands in the ponderosa pine and ponderosa pine-Douglas-fir cover types, Camp Creek drainage. Before 1950, frequent nonlethal (NL) fires predominated on dry exposed slopes. Frequent mixed severity (MS_I) and nonlethal fires also occurred in low- to mid elevation riparian ("R") stands and on moist north-facing slopes.

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	Reg. type	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
1	Psme/ Spbe	PP	W	4400	NL	1799-1948	16	6-16	10	52
2R	Abgr/ Acgl	PP-DF	SW	4200	NL (MS-I)	1814-1948	11	7-22	13	52
3	Pipo/ Putr	PP	SW	4300	NL	1780-1948	18	3-19	10	52
4	Pipo/ Putr	PP	W	4400	NL	1696-1948	20	5-29	13	52
5	Pipo/ Phma	PP	W	5200	NL	1747-1948	15	5-29	14	52
6	Pipo/ Putr	PP	W	5000	NL	1738-1940	22	4-20	10	60
7	Pipo/ Putr	PP	SW	5200	NL	1688-1940	30	2-20	9	60
8R	Abgr/ Acgl	PP-DF	S	4150	MS_I (NL)	1688-1918	13	4-39	19	82
9R	Abgr/ Acgl	PP-DF	N	4500	MS_I (NL)	1760-1889	8	8-31	18	111
10R	Abgr/ Acgl	PP-DF	W	4500	NL (MS-I)	1771-1918	15	5-19	11	82
11	Psme/ Phma	PP	S	5500	NL	1711-1918	16	2-36	14	82
12	Psme/ Phma	PP-DF	SE	6100	MS-I (NL)	1688-1956	10	11-57	29	44
13	Psme/ Phma	PP-DF	NW	6300	MS_I (NL)	1623-1918	15	4-28	21	82
15	Psme/ Spbe	PP-DF	S	6300	NL	1760-1932	12	5-29	16	68

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	Reg. type	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
16	Psme/ Phma	PP-DF	W	6100	NL	1733-1940	18	3-19	12	60
17R	Psme/ Phma	PP-DF	NW	4000	NL	1799-1948	15	4-15	11	52
22	Psme/ Caru	DF	SW	7300	NL	1830-1940	10	4-19	12	60
	***Range* (*all stands*):**			**4150-7300'**		**1623-1956**	**8-30**	**2-57**	**9-29**	**44-111**
	***Means* (*all stands*):**			**5144'**			**16**	**5-25**	**15**	**65**
	***MEANS*:**			**Non-Riparian Stands (*12 stds*):**				**5-27**	**14**	**59**
				Riparian Stands (*5 stds*):				**6-25**	**14**	**75**

***Mean* MFIs:** **NL Regime (*13 stds*) : 12 yr**
MS_I Regime (*4 stds*): 22 yr

1. Based on clustered plots (map on file, Payette NF) (R=riparian stand).
2. Habitat type acronymns follow Steele et al. (1981).
3. PP: ponderosa pine DF: Douglas-fir WL: western larch LP: lodgepole pine SF: spruce-subalpine fir
4. Stand Master Fire Chronology.
5. N=number of fires
6. Mean Fire Interval (Arno and Sneck 1977).
7. Years since last wildfire, as of 2000 (excluding post-1988 RX fires).

have not experienced fire for the past 75 years, on average. The fire interval data thus suggest that future wildfires likely will be unnaturally severe in riparian zones, especially because those are the most productive sites in the lower elevations.

These findings of seriously impacted fire frequency in ponderosa pine stands are supported by other fire history studies in central Idaho and eastern Oregon (Bork 1984, Barrett 1988a, Barrett 1988b, Maruoka 1994, Barrett 1994a, Barrett 1994b, Heyerdahl and Agee 1996, Heyerdahl 1997, Barrett 1998). For example, during a 1984 study in the Frank Church River of No Return Wilderness (Barrett 1988b), 90 percent of the ponderosa pine sample stands in the Salmon River Breaks had not burned since 1935 or earlier. Subsequently, extensive stand replacing fires have occurred in those historical low severity fire regimes in the main Salmon River Canyon, and elsewhere.

Montane Mixed Conifer/Lodgepole Pine. Historical fire regimes were substantially different in the upper elevations of the Camp Creek drainage (Table 2). Stands dominated by western larch/Douglas-fir, or by pure lodgepole pine, experienced less frequent mixed severity (MS) and stand replacing (SR) fires. Data from 10 sample stands revealed that relatively severe MS fires, with intervals ranging from about 30 to 100 years long, occurred on mid-elevation north slopes in the montane zone, and in comparatively dry subalpine stands. The overall MFI for the MS_II regime was 64 years, similar in length to the average current fire interval (i.e., 70 yr). Therefore, although these stands are still experiencing natural succession, the data suggest that fire exclusion has extended many fire intervals toward the upper end of the historical range. As a result, future fires are likely to be among the most severe ever experienced in this fire regime. Evidence of such severe burning already exists, for example, a 1992 wildfire in

Table 2. Fire regimes data from 20 stands in the lodgepole pine and western larch-Douglas-fir cover types, Camp Creek drainage. Stands in the upper elevation zones were recycled by infrequent mixed severity (MS_II) and stand replacing (SR) fires.

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	Reg. type	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
14	Abla/ Vagl	MC	W	6000	MS_II	1382-1857	8	26-123	68	143
18	Abgr/ Vagl	MC	N	6000	MS_II	1677-1889	6	22-61	42	111
19	Abgr/ Vagl	WL-DF	N	5800	MS_II	1747-1889	3	39-103	71	111
20	Abgr/ Vagl	LP-DF	NW	6600	MS_II	1718-1992	5	9-139	69	8
21	Abla/ Vagl	LP	N	6900	SR	1866-1992	2	126	-	8
23	Abla/ Vagl	LP	W	7100	MS_II	1677-1992	6	16-189	63	8
24	Abla/ Vagl	LP	W	6800	MS_II	1785-1992	4	52-81	69	8
25R	Abla/ Cabi	S-F	NW	6400	SR	1662-1950	2	47-241+	144+	291
26	Abla/ Vagl	LP	W	6500	SR	1830-1950+	1	120+	-	170
27R	Abla/ Vasc	LP	F	5900	SR	1760-1950+	1	190+	-	240
28	Abla/ Xete	S-F	NW	7600	SR	1565-1950+	2	83-302+	193+	352
29	Abla/ Vasc	LP	SW	7700	SR	1696-1950+	1	254+	-	304
30	Abla/ Vasc	LP	SW	7800	MS_II	1785-1866	3	29-52	41	134
31	Abla/ Vasc	LP	SW	7500	MS_II	1637-1940	5	59-98	76	60

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	Reg. type	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
32	Abla/ Cage	LP	SW	7600	SR	1649-1940	2	291	-	60
33	Abla/ Vasc	LP	N	7500	SR	1637-1950+	1	313+	-	363
34	Abla/ Vasc	LP	W	7300	SR	1654-1940	3	74-212	143	60
35	Abla/ Vasc	LP	W	7500	MS_II	1824-1992	3	42-126	84	8
36	Abla/ Vagl	LP	NE	6500	MS_II	1785-1889	3	23-81	52	111
37	Abla/ Vasc	LP	NW	7280	SR	1785-1950+	1	165+	-	215

***Means*, MS_II Regime (*10 stds*) — Interval Range: 32-105 yr**
MFI : 64 yr
Last Fire : 70 yr

***Means*, SR Regime (*10 stds*) — Interval Range: 47-313+ yr**
MAFI[8] : 186 yr
Last Fire : 206 yr

1. Based on clustered plots (map on file, Payette NF) (R=riparian stand).
2. Habitat type acronymns follow Steele et al. (1981).
3. DF: Douglas-fir WL: western larch MC: mixed conifer LP: lodgepole pine S-F: spruce-subalpine fir
4. Stand Master Fire Chronology ("+" denotes interval as of 1950).
5. N=number of fires
6. Mean Fire Interval ("+" denotes inclusion of incomplete fire interval as of 1950).
7. Years since last wildfire, as of 2000.
8. Multiple Site Average Fire Interval (Barrett and Arno 1988).

the upper elevations of the drainage killed most trees within the burn perimeter. Additionally, many mature and previously fire-resistant Douglas-fir were killed during the wildfire, unlike during the historical era.

A dominant pattern of moderately frequent mixed severity fires in relatively productive mid- to upper elevation stands, followed by a period of effective fire exclusion, has been found elsewhere in central Idaho and eastern Oregon (Barrett 1987, Barrett 1994b, Heyerdahl and Agee 1996, Heyerdahl 1997). For example, similar results were obtained for mid- to upper elevation stands in the Bear Analysis Area near Council, Idaho, on the Payette National Forest, (Barrett 1994b). Three sites yielded an average MFI of 76 years for mixed severity fires during the presettlement era, versus a current fire interval of 101 years.

Evidence of a historical stand replacement (SR) fire regime was scarce in the Camp Creek drainage, and elsewhere in the South Fork (as discussed below). Specifically, only the steepest upper elevation slopes produced evidence of stand replacing fires. These fires averaged about every 186 years, in comparison with the average current fire interval of 205 years long. Overall, therefore, the data for upper elevation fire regimes (i.e., MS_II, SR) suggest that major fires may be imminent in this portion of the South Fork. Most upper elevation stands are still experiencing natural succession, by virtue of inherently long fire intervals relative to the fire suppression period to date. However, the fact that long-term fire exclusion has promoted increased interval lengths suggests that future fire severities, sizes, and spread patterns, will likely be outside the historical range of variability at the landscape scale in the Camp Creek area.

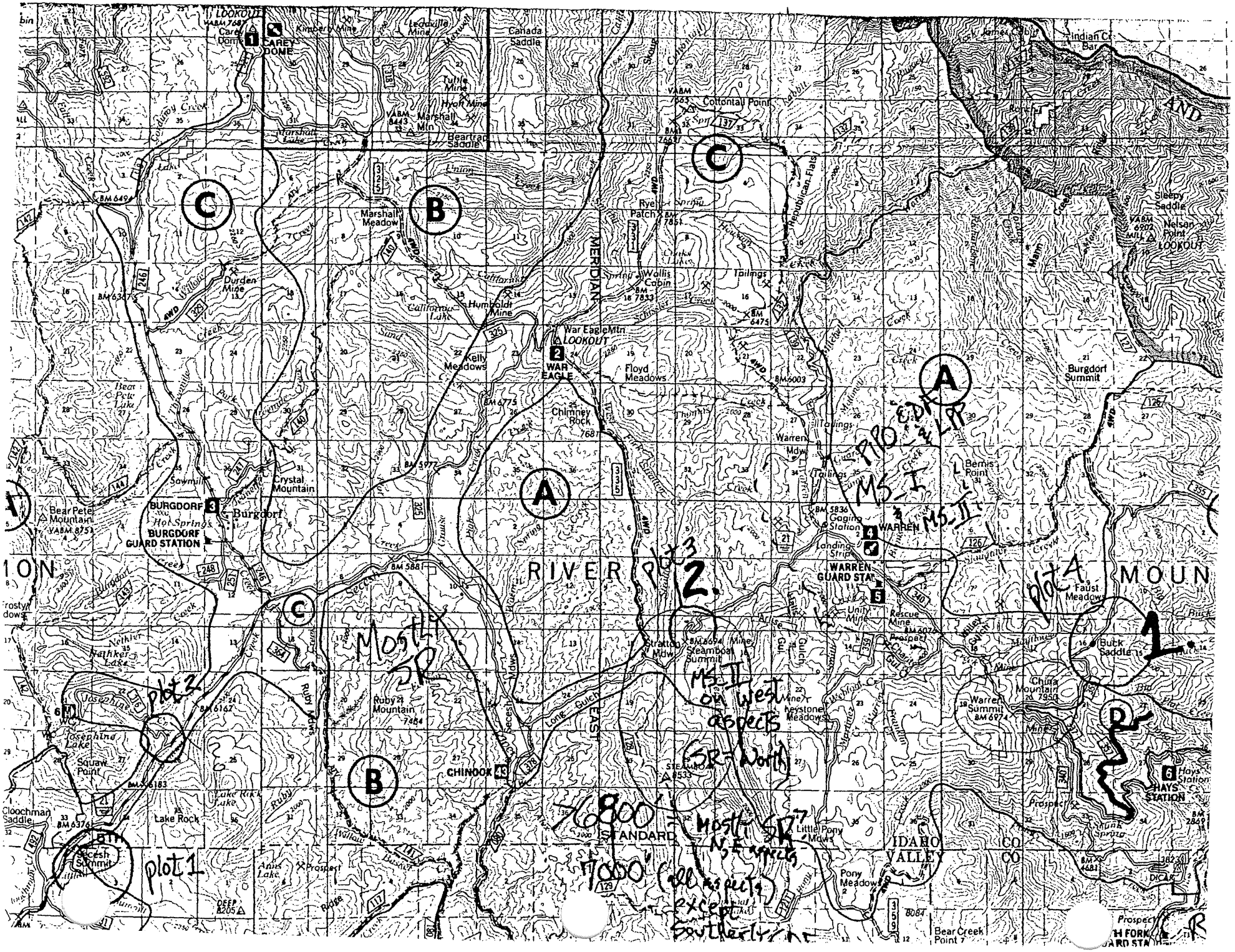
Year 2000 Reconnaissance Sampling. During summer 2000, the sampling effort was expanded geographically to cover a more extensive area of the South Fork drainage. Specific goals were to focus on the upper elevation fire regimes, to determine the extent of the stand replacement fire regime in the South Fork. Additionally, the sampling focused on determining the relationship between stand replacement fire regime and the various mixed severity fire regimes.

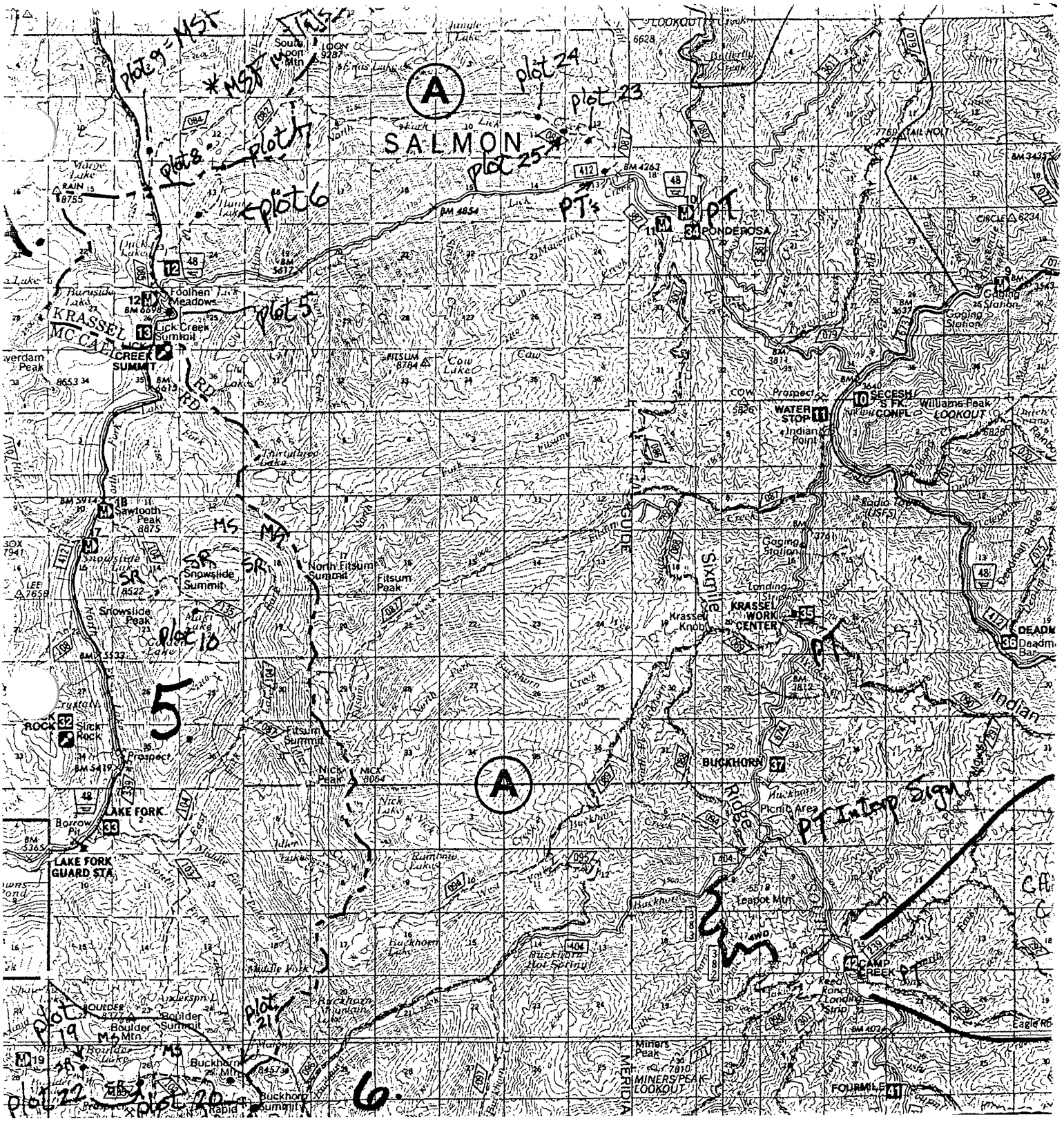
A total of 25 reconnaissance plots were subjectively located at various geographic locations throughout the South Fork drainage. Initially, maps were reviewed in the office to identify potential sampling areas, and the plan was to use area roads and trails for sampling efficiency. These pre-identified areas were then visited in the field to verify sampling potential. Within each area, sample plots were located subjectively, favoring those sites with potential to yield the most long-term and highest quality fire history information.

Geographically, the array of reconnaissance plots spans from the northern end of the South Fork (e.g., Warren Summit area, Payette NF) to the southern end of the drainage (e.g., near Stolle Meadows and Summit Lake, Boise NF)(fig. 2). The plot elevations generally range from about 5000 to 7700 feet, with most plots averaging above 6000 feet. Therefore, the most common forest cover types encountered during the reconnaissance sampling were lodgepole pine and whitebark pine. The results from the individual plots are described below, progressing from the northern to the southern end of the South Fork drainage. Additionally, the results from the reconnaissance sampling have been merged with those from the Camp Creek drainage to provide comprehensive data for use in fire regimes modeling (Tables 3-5). (Note: The Appendix contains the GPS locational data for all plots sampled in 1999 and 2000).

Figure 2. Year 2000 Plots (Map Code below).

PLOT	STAND (see Tables 3-5)
1	SS1
2	JL1
3	ST1
4	BS1
5	LC1
6	HL1
7	HL2
8	LL1
9	DL1
10	ML1
11	BC1
12	CCR1
13	CCR2
14	MC1
15	WL1
16	DC1
17	BLS1
18	BLS2
19	BL1
20	BH1
21	BH2
22	BL2
23	SP1
24	NF1
25	NF2


CARRY DOME
WAR EAGLE
BURGDORF GUARD STATION
WARREN
WARREN GUARD STAT
CHINOOK
HAYS STATION
RIVER
MERIDIAN
EAST
STANDARD
IDAHO VALLEY
Most SR
plot 2
plot 1
plot 3
plot 4
MS_I
MS_II
RPO_EDP_LRP
Most SR
MS_I on west aspects
SR - North
Most SR
NE aspects
(all aspects except Southerly)
7,800'
7,000'


SALMON
A
plot 1
plot 2
plot 3 MST
plot 4
plot 5
plot 6
plot 23
plot 24
plot 25
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North Fitsum Summit
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Nick Peak
Sixmile
Krassel Knobs
KRASSEL WORK CENTER
Indian Point
WATER STOP
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Williams Peak LOOKOUT
PONDEROSA
Gaging Station
Landing Strip
Picnic Area
Leapot Mtn
CAMP CREEK
Reed Ranch Landing Strip
BUCKHORN
Buckhorn Mtn
Buckhorn Summit
Boulder Mtn
Boulder Summit
LAKE FORK
LAKE FORK GUARD STA
Borrow Pit
Slick Rock
Prospect
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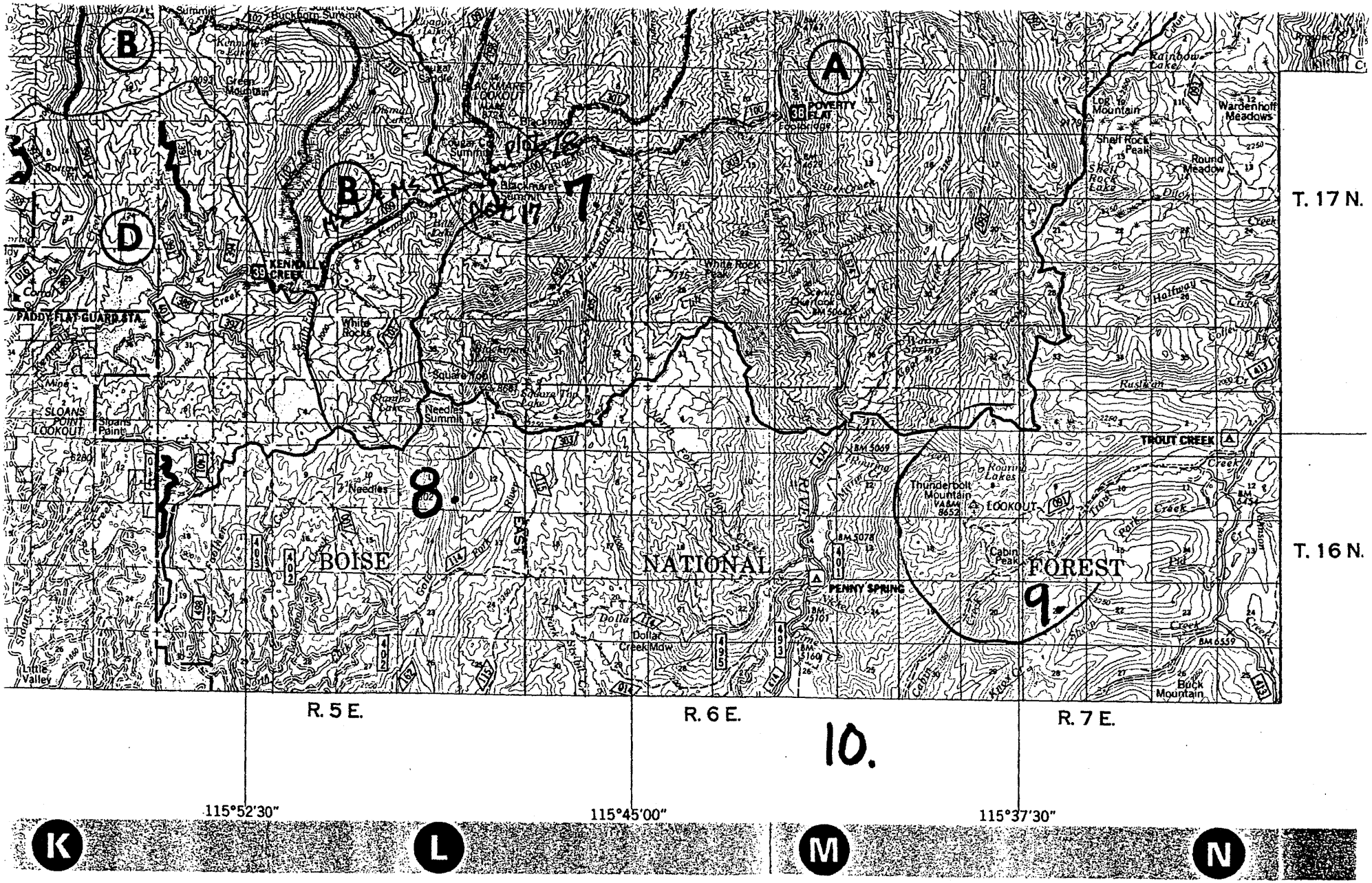
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White Rock Peak
Thunderbolt Mountain
LOOKOUT
Roaring Lakes
Cabin Peak
Shell Rock Peak
Shell Rock Lake
Rainbow Lake
Log Ty Mountain
Wardenhoff Meadows
Round Meadow
Buck Mountain
Dollar Creek Mdw
Little Valley
Green Mountain
Blackmare Summit
Buckhorn Summit
Bear Saddle
Square Top Lake
Needles
Sloans Point
Halfway Creek
Rush Creek
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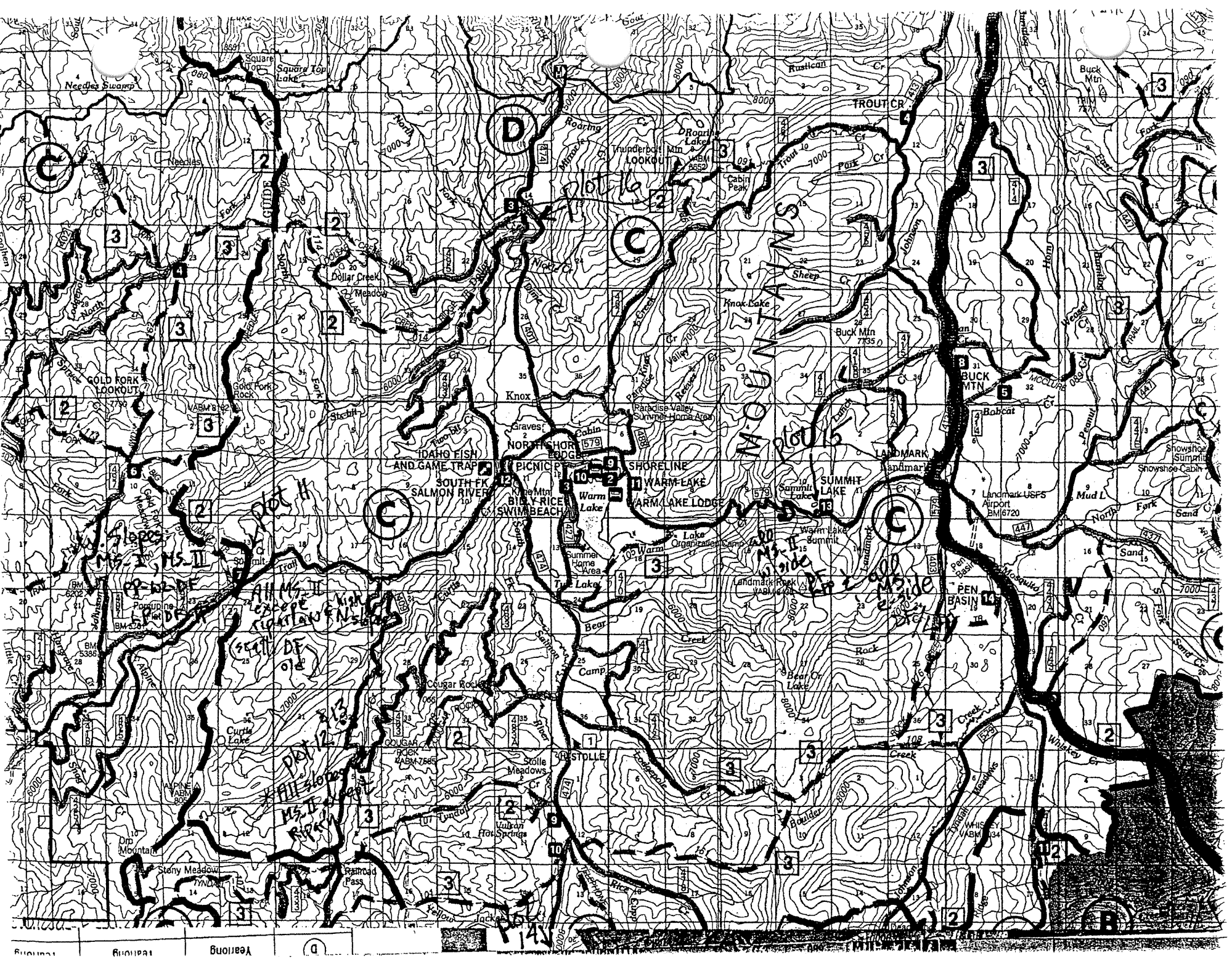
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WARM LAKE LODGE
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Warm Lake Summit
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Bear Cr Lake
Cougar Rock
Curtis Lake
COUGAR ROCK
Stolle Meadows
STOLLE
Vulcan Hot Springs
Dry Mountain
Stony Meadow
Railroad Pass
Whiskey Meadows
Boulder Creek
Johnson Ridge
Porcupine Flat
Plot H
Plot 14
Plot 12
Plot 13
Plot 16
MS-I, MS-II
MS-II
MS-I
DF
SCATTERED OLD
All MS-II except right aspect NS slopes
MS-II steep slopes
MS-I, MS-II
MS-I Rocky
MS-I Rocky
MS-II steep slopes
MS-II steep slopes
MS-II steep slopes

Table 3. Comprehensive fire regimes data from 15 stands in the MS_II Fire Regime (e.g., montane lodgepole pine and western larch-Douglas-fir cover types), South Fork Salmon River drainage.

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
cc14	Abla/ Vagl	MC	W	6000	1382-1857	8	26-123	68	143
cc18	Abgr/ Vagl	MC	N	6000	1677-1889	6	22-61	42	111
cc19	Abgr/ Vagl	WL-DF	N	5800	1747-1889	3	39-103	71	111
cc20	Abgr/ Vagl	LP-DF	NW	6600	1718-1992	5	9-139	69	8
cc23	Abla/ Vagl	LP	W	7100	1677-1992	6	16-189	63	8
cc24	Abla/ Vagl	LP	W	6800	1785-1992	4	52-81	69	8
cc30	Abla/ Vasc	LP	SW	7800	1785-1866	3	29-52	41	134
cc31	Abla/ Vasc	LP	SW	7500	1637-1940	5	59-98	76	60
cc35	Abla/ Vasc	LP	W	7500	1824-1992	3	42-126	84	8
cc36	Abla/ Vagl	LP	NE	6500	1785-1889	3	23-81	52	111
ccr2	Abla/ Vasc	LP-DF	S	6200	1801-1966	3	67-98	83	34
wl1	Abla/ Vasc	LP	W	7300	1779-1994	3	67-81	72	6

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
sp1	Abgr/ Vagl	PP-DF-WL	SE	4950	1702-1944	7	15-92	40	56
nf2	Abgr/ Vagl	WL-DF	N	6000	1680-1901	3	87-134	110	99

***Means*, MS_II Regime (*15 stds*) — Interval Range: 9-189 yr**
MFI: 63 yr
Last Fire: 60 yr

1. Plot location map on file, Payette NF (R=riparian stand).
   Locations Code: cc=Camp Cr; ss=Sesech Summit; jl=Josephine Lk Rd; st=Steamboat Summit; bs=Buck Saddle; lc=Lick Cr Summit; hl=Hum Lk basin; ll=Loon Lks basin; dl=Duck Lk north; ml=Maki Lk; bc=Big Cr Summit; ccr=Curtis Cr; mc=Mormon Cr Rd; dc=Dollar Cr; bls=Blackmare Summit; bl=Boulder Lk; bh=Buckhorn Summit; nf=N. Fk. Lick Cr; sp=Split Cr.
2. Habitat type acronymns follow Steele et al. (1981).
3. PP: ponderosa pine DF: Douglas-fir WL: western larch MC: mixed conifer LP: lodgepole pine S-F: spruce-subalpine fir
4. Stand Master Fire Chronology ("+" denotes incomplete fire interval).
5. N=number of fires
6. Mean Fire Interval ("+" denotes inclusion of incomplete fire interval).
7. Years since last wildfire, as of 2000.
8. Multiple Site Average Fire Interval (Barrett and Arno 1988).

Table 4. Comprehensive fire regimes data from 25 stands in the SR Fire Regime (e.g., lodgepole pine and spruce-fir cover types), South Fork Salmon River drainage.

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
cc21	Abla/ Vagl	LP	N	6900	1866-1992	2	126	-	7
cc25 R	Abla/ Cabi	S-F	NW	6400	1662-1950	2	47-241+	144 +	290
cc26	Abla/ Vagl	LP	W	6500	1830-1950+	1	120+	-	169
cc27 R	Abla/ Vasc	LP	F	5900	1760-1950+	1	190+	-	239
cc28	Abla/ Xete	S-F	NW	7600	1565-1950+	2	83-302+	193 +	351
cc29	Abla/ Vasc	LP	SW	7700	1696-1950+	1	254+	-	303
cc32	Abla/ Cage	LP	SW	7600	1649-1940	2	291	-	59
cc33	Abla/ Vasc	LP	N	7500	1637-1950+	1	313+	-	362
cc34	Abla/ Vasc	LP	W	7300	1654-1940	3	74-212	143	59
cc37	Abla/ Vasc	LP	NW	7280	1785-1950+	1	165+	-	214
ss1	Abla/ Xete	LP	N/F	6510	1804-1994	2	104	-	6
jl1	Abla/ Xete	LP	N	6240	1716-1994	3	65-213	139	6
st1	Abla/ Xete	LP	N	6680	1774-1942	2	168	-	58
bs1	Abla/ Xete	LP	F/ NW	7800	1823-1994	2	171	-	6

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
lc1	Abla/ Xete	LP	N	6700	1635-1994	3	156-203	180	6
hl1	Abla/ Xete	LP-WB	NE	7700	1791-1994	3	51-152	102	6
ll1	Abla/ Xete	LP-WB	N	7400	1791-1994	2	203	-	6
ml1 R	Abla/ Vasc	S-F	N	7300	1739-2000	1	261+	-	261
bc1	Abla/ Vagl	LP	NE	6590	1761-2000	1	239+	-	239
ccr1 R	Abla/ Vagl	LP	NE	6150	1799-1966	2	168	-	34
mc1 R	Abla/ Vagl	LP	NE	5900	1860-1994	2	134	-	6
dc1 R	Abla/ Vagl	LP	N	5100	1895-1994	2	99	-	6
bl1 R	Abla/ Vagl	LP	N	6500	1862-2000	1	138+	-	138
bl2 R	Abla/ Vagl	S-F	N	7000	1762-2000	1	238+	-	238
nf1 R	Abla/ Xete	LP	N/F	5800	1814-1901	2	89	-	99

***Means* (25 *stds*), Interval Range: 47-313+ yr**
MAFI[8] : 170 yr
Last Fire : 127 yr

1. Plot location map on file, Payette NF (R=riparian stand).
   Locations Code: cc=Camp Cr; ss=Sesech Summit; jl=Josephine Lk Rd; st=Steamboat Summit; bs=Buck Saddle; lc=Lick Cr Summit; hl=Hum Lk basin; ll=Loon Lks basin; dl=Duck Lk north; ml=Maki Lk; bc=Big Cr Summit; ccr=Curtis Cr; mc=Mormon Cr Rd; dc=Dollar Cr; bls=Blackmare Summit; bl=Boulder Lk; bh=Buckhorn Summit; nf=N. Fk. Lick Cr; sp=Split Cr.
2. Habitat type acronymns follow Steele et al. (1981).
3. LP: lodgepole pine WB: whitebark pine S-F: spruce-subalpine fir
4. Stand Master Fire Chronology ("+" denotes incomplete fire interval).
5. N=number of fires
6. Mean Fire Interval ("+" denotes inclusion of incomplete fire interval).
7. Years since last wildfire, as of 2000.
8. Multiple Site Average Fire Interval (Barrett and Arno 1988).

Table 5. Comprehensive fire regimes data from 6 stands in the MS_III Fire Regime (e.g., whitebark pine cover type), South Fork Salmon River drainage.

Std. No.[1]	Hab. Type[2]	Cov. Type[3]	Asp.	Elev (ft)	MFC[4]	N[5]	Intvl. Range (yr)	MFI (yr)[6]	Last Fire[7] (yr)
hl2	Abla/ Vasc	WB	S	7800	1357-1994	2	251 (poss. 637)	-	6
dl1	Abla/ Xete	LP-WB	SW	7700	1487-1994	4	60-304	169	6
bls1	Abla/ Luhi	LP-WB	F	7950	1667-1866	3	54-142	98	134
bls2	Pial/ Abla	WB	S	7700	1667-1934	5	34-129	68	66
bh1	Pial/ Abla	WB	E	7900	1762-1949	2	187	-	51
bh2	Pial/ Abla	WB	S	8300	1599-1901	2	302 (poss. 401)	-	99

***Means (6 stds),* Interval Range: 151-300 yr**
MFI (3 stds): 112 yr
MAFI (6 stds): 198 yr
Last Fire: 60 yr

1. Plot location map on file, Payette NF (R=riparian stand).
   Locations Code: cc=Camp Cr; ss=Sesech Summit; jl=Josephine Lk Rd; st=Steamboat Summit; bs=Buck Saddle; lc=Lick Cr Summit; hl=Hum Lk basin; ll=Loon Lks basin; dl=Duck Lk north; ml=Maki Lk; bc=Big Cr Summit; ccr=Curtis Cr; mc=Mormon Cr Rd; dc=Dollar Cr; bls=Blackmare Summit; bl=Boulder Lk; bh=Buckhorn Summit; nf=N. Fk. Lick Cr; sp=Split Cr.
2. Habitat type acronymns follow Steele et al. (1981).
3. LP: lodgepole pine WB: whitebark pine
4. Stand Master Fire Chronology ("+" denotes incomplete fire interval).
5. N=number of fires
6. Mean Fire Interval ("+" denotes inclusion of incomplete fire interval).
7. Years since last wildfire, as of 2000.
8. Multiple Site Average Fire Interval (Barrett and Arno 1988).

Sesech Summit. Several plots were placed along the Warren Wagon Road, as far north as Buck Saddle near Warren Summit. The first plot was placed near Sesech Summit, a north-facing stand destroyed by fire in 1994. The plot is located at 6500 feet elevation, with a predominant cover type of even aged lodgepole pine (*Abla/Xete* h.t.). The site apparently occurs in the stand replacement fire regime, since the site contained only one age class regenerated in about 1804 and no fire scarred trees were found in the general area. As with most plots in the SR regime, calculating an individual site MFI was not possible because there was usually evidence of just one fire interval (i.e., 1804 to 1994). That interval was 190 years long, and the multiple site average fire interval from all SR sites sampled in the South Fork drainage was 170 years long.

Josephine Lake. This northeast facing lodgepole pine stand (*Abla/Xete* h.t.) is located near the start of the Josephine Lake road, at 6200 feet elevation. Three single-aged lodgepole pine mosaics predominate in the area mosaic, a result of stand replacing fires in 1716, 1931, and 1994. The data thus yielded a site MFI of 139 years long, and the stand replacement intervals were 65 and 213 years long.

Steamboat Summit. This north-facing lodgepole pine stand (*Abla/Xete* h.t.) is about one-quarter mile northwest of Steamboat Summit, at 6700 feet elevation. The site yielded evidence of a single stand replacement fire interval that was 168 years long between 1774 and 1942. As with the plots described above, the occurrence of mostly single-age lodgepole pine stands, and a general lack of widespread fire-scarred trees, yields an interpretation that the SR regime predominates on northerly aspects along that portion of the Warren Wagon Road.

Buck Saddle. This west-facing lodgepole pine stand (*Abla/Xete* h.t.) is at Buck Saddle (7800 ft elev.), about three miles northeast of Warren Summit. This stand, and many

others in the area, were replaced during the severe 1994 fire season. Due to recurrent stand replacing fires, the site yielded just one fire inteval—171 years long between 1823 and 1994.

Loon Lakes Basin. This northerly facing stand is dominated by lodgepole pine and whitebark pine (*Abla/Xete* ht) at the head of the Loon Creek drainage. The lake basin is at 7400 feet elevation, and the plot sampling produced evidence of two stand replacing fires, in 1791 and 1994. Therefore, the single SR fire interval was 203 years long.

Duck Lake North. This steep southwest facing stand due northeast of Duck Lake is dominated by whitebark pine and lodgepole pine, and occurs in the MS_III fire regime type. Dry site conditions and discontinuous fuels promote a predominance of mixed severity fires. For example, fire spread was patchy and mortality was mixed even during the severe 1994 fire season. The master fire chronology documents fires in about 1487, 1791, 1934, and 1994. Consequently, the fire intervals ranged from about 60 to 300 years long, and the MFI was 169 years long for the MS_III regime type.

Hum Lake 1. This northeast facing stand is dominated by whitebark pine and lodgepole pine (7700 ft), just northeast of the Hum Lake saddle. Evidence of three stand replacing fires was found in and around this site, dating to about 1791, 1842, and 1994. Consequently, the fire intervals ranged from about 50 to 150 years long, and the MFI for stand replacing fires was 102 years long.

Hum Lake 2. This whitebark pine-dominated stand (*Abla/Vasc* ht) occupies a comparatively dry south facing site on the divide between Hum Lake and Loon Creek (7800 ft). The site occurs in the MS_III fire regime, and contains whitebark pines up to an estimated 1000 years old. For example, the oldest whitebark pine sample dated to about 1357 A.D.. The site had

evidence of two or three MS fires, but the highly scattered uneven age regeneration makes fire year verification difficult. As a result, the most feasible way to estimate fire frequency is to calculate a multiple site average fire interval (MAFI)(Barrett and Arno 1988), which is 198 years long based on the six sites sampled in the South Fork's high elevation MS_III fire regime type.

Lick Creek Summit. This lodgepole pine and whitebark pine-dominated site (*Abla/Xete* ht) occupies a gentle north facing slope at 6700 feet elevation immediately southeast of Lick Creek Summit. Many stands in the area were replaced in the 1994 fire season, and previous stand replacing fires occurred in about 1635 and 1791. The 156- and 203-year-long fire intervals therefore yield an 180-year long MFI for stand replacing fires on the area's north slopes.

Split Creek. This steep dry site on the west side of Split Creek occurs at 4950 feet elevation in the montane forest zone, dominated by ponderosa pine and Douglas-fir (*Abgr/Vagl* ht). An estimated seven fires occurred between 1702 and 1944. These data yielded a fire interval range of from 15 to 92 years long, and the MFI was 40 years long. Consequently, the site occurs in the MS_II fire regime type. Although the current fire interval of 56 years long is still within the HRV, a moderate amount of infilling by shade tolerant trees has occurred, suggesting that future fires likely will be relatively severe.

North Fork Lick Creek 1. This site occurs in the middle portion of the North Fork of Lick Creek drainage, a riparian stand dominated by lodgepole pine and spruce (*Abla/Xete* ht) in the lower subalpine zone (5800 ft elevation). The site yielded evidence of two stand replacing fires, in 1814 and 1901, therefore, calculating a site MFI was not possible. Alternatively, using the MAFI of 170 years derived from all stands in the SR type is the only feasible way to describe fire frequency without two or more fire intervals. As with the other SR

sample sites, the current fire intervals are well within the HRV. That is, such sites are still on a natural fire cycle.

North Fork Lick Creek 2. This steep, moist site sits at 6000 feet elevation on a north facing slope above the lower end of the North Fork of Lick Creek. The stand is dominated by at least three even age classes of western larch, lodgepole pine, and Douglas-fir (*Abgr/Vagl* ht), and occurs at the upper limits of the MS_II fire regime type. Evidence of three fires between 1602 and 1901 was found, yielding a site MFI of 110 years long. In comparison, the current fire interval is 99 years long, and the stand is declining in vigor because of root rot and insects. Consequently, the next fire event likely will be a severe disturbance.

Maki Lake. The north facing old growth spruce-fir stand on the south side of Maki Lake produced one of the longest intervals documented for stand replacing fires in the data. The fire interval was still incomplete as of 2000 (i.e., the interval is based on the oldest spruce in the current stand), but the current stand age is estimated to be at least 261 years old. Spruce-fir dominated sites likely experience some of the longest stand replacement intervals in the South Fork drainage, because the chronically moist and shaded fuels often discourage the spread of mixed severity fires that occur on adjacent dry southerly aspects (i.e., in lodgepole pine/whitebark pine dominated stands). Conversely, infrequent ignitions in the highly flammable spruce-fir stands, especially during heavy drought, usually promotes total stand replacement burning.

Boulder Lake 1. Sampling in this riparian lodgepole pine-western larch stand next to upper Boulder Creek revealed that the current fire interval (i.e., maximum stand age) was about 138 years old as of 2000. The interpretation is that this cool, moist, and highly productive site is likely in the SR fire regime, because the stand is one-aged and such sites usually lack

substantial numbers of fire scarred trees.

Boulder Lake 2. Similar to the Maki Lake stand, this north facing spruce-fir stand on the south side of Boulder Lake provided one of the longest intervals documented for stand replacing fires in the data. That is, the current fire interval, which was incomplete as of 2000, is estimated to be about 240 years long. Consequently, the sampling further supports the interpretation that riparian spruce-fir stands likely experience some of the longest replacement intervals in the South Fork drainage.

Buckhorn Summit 1. This east facing stand is dominated by whitebark pine and lodgepole pine occurs on Buckhorn Summit at 7900 feet elevation. The stand is relatively open grown and contains multiple fire regenerated seral age classes, suggesting a history of mixed severity burning. Sampling revealed two fires, in about 1762 and 1949, yielding a 187-year long fire interval. Since deriving an MFI was not possible, the interval was used in calculating the 198-year-long overall MAFI estimated for the high elevation MS_III fire regime type.

Buckhorn Summit 2. This southerly facing whitebark pine-dominated stand, at 8300 feet elevation, also has light stocking, and apparently contains multiple fire regenerated age classes. The sampling suggested two fires occurred, in 1599 and 1901, which does not yield an MFI but provides a 302-year-long fire interval for calculating MAFI. Again, the MAFI of 174 years is considered representative for high elevation sites in the MS_III fire regime.

Blackmare Summit 1. This plot is on Blackmare Summit, a west facing and open ridge top stand dominated by lodgepole pine and whitebark pine. Sampling produced evidence of three mixed severity fires between 1667 and 1866. As with other stands in the high elevation MS_III regime, the fire intervals ranged widely, from 54 to 142 long, and the stand MFI was 98

years long. Although the stand has not burned during the past 134 years, fire exclusion has not markedly influenced stand succession in light of the wide ranging presettlement fire intervals in this fire regime type.

Blackmare Summit 2. This open, south facing stand is dominated by whitebark pine at the head of Blackmare Creek, about one-quarter mile north of the Blackmare 1 stand. Dominant whitebark pines up to an estimated 1000 years old, often containing basal fire scars, occupy the head of the basin. Such factors are initially diagnostic of the high elevation MS_III fire regime type. This pattern was verified by the plot sampling, which yielded evidence of five fires between 1667 and 1934. The intervals ranged widely, from 34 to 129 years, and the MFI was 68 years long. By comparison, because the last fire occurred 66 years ago, fire exclusion apparently has not affected the upper basin of the Blackmare drainage.

Dollar Creek. This lodgepole pine-dominated site is a riparian stand in the South Fork canyon bottom, about five miles north of Warm Lake. The stand apparently represents the lower elevational limits of the stand replacement fire regime found in the South Fork drainage (i.e., 5100 ft). SR fires occurred on this site in 1895 and 1994, yielding a 99-year-long SR fire interval. That interval was one of the shortest SR intervals found in the drainage, not surprising because NL and MS-type fires were frequent on the adjacent dry slopes before 1900.

Big Creek Summit. Sampling on this low elevation pass produced evidence of the stand replacement fire regime, but largely on northerly aspects dominated by lodgepole pine. That is, the dominant and highly senescent lodgepole pine age class in this area regenerated after a fire in about 1761, and fire scar trees are rare on upper elevation northerly aspects. Because the 239-year-long fire interval apparently is now nearing completion, that incomplete interval was used in

calculating the overall 170-year-long MAFI for stand replacing fires in the South Fork.

Curtis Creek 1. This riparian stand is dominated by lodgepole pine (*Abla/Vagl* ht), and has evidence of consecutive stand replacing fires in 1799 and 1966. As at the Dollar Creek site, this stand and fire regime type occupies a narrow riparian strip surrounded by the predominant MS_II fire regime throughout the headwaters of the South Fork. However, the 168-year long fire interval for that site equals the overall MAFI of 170 years for the SR fire regimes model in the South Fork drainage.

Curtis Creek 2. This dry south-facing stand, about a mile southwest of the Curtis Creek 1 stand, represents the area's dominant MS_II fire regime type. Specifically, this multi-age stand is dominated by lodgepole pine and Douglas-fir, and fire scarred trees are commonplace. The sampling revealed evidence of three fires between about 1801 and 1966, which produced an 83-year-long MFI. Because the presettlement fire intervals ranged from 67 to 98 years long, the current 34-year-long fire interval is well within the HRV and the stand is on a natural successional cycle.

Mormon Creek. This plot represents the southernmost sample stand in the study, an even-aged lodgepole pine-dominated stand near the Eureka Silver King Mine, in the South Fork headwaters. As with the other SR sample stands in this area, the SR fire regime apparently is limited to riparian stream bottoms and steep north facing slopes. For example, the Mormon Creek riparian stand had evidence of two consecutive SR fires, in about 1860 and 1994, producing a 134-year-long SR fire interval for the site.

Warm Lake Summit. Samples from a west facing lodgepole pine-whitebark pine stand at Summit Lake (i.e., Warm Lake Summit) revealed the area's predominant MS_II fire

regime type. Specifically, an estimated three fires occurred between 1779 and 1994, yielding a 72-year-long site MFI. This result is similar to the overall MFI of 63 years for the MS_II fire regime type. This site may represent the upper elevational limits of the MS_II regime, since the MS_III fire regime type generally was found above 7500 feet elevation in the South Fork drainage.

Successional Trends by Fire Regime Type. Stand level information (i.e., tree species composition and density) taken at the sample plots were used to interpret pre- and post-1900 successional trends. For lower elevation forests, the plot data suggest that fire exclusion has altered stand structure and species composition in many ponderosa pine-dominated stands, particularly on comparatively productive sites. An exception is that the driest ponderosa pine stands are often still relatively open grown, even where long-term fire exclusion has been effective (i.e., NL regime). That is, many sites remain lightly stocked because of thin soils and inherently high drought stress (Steele et al. 1981). However, scattered thickets of Douglas-fir still produce high fuel concentrations locally. On those sites, typically with southerly aspects, duff and litter buildups at the bases of old trees likely represent the most serious impact from fire exclusion. The implication is that future fires will generate unnaturally high levels of mortality where smoldering duff and litter is allowed to persist for long periods. For example, long-term accretion of litter and duff can also promote lethal scorching of tree root crowns during fires, and surviving scorched trees often become vulnerable to insects and diseases (Barrett 1988, Arno et al. 1995).

Effective fire exclusion also has affected wildlife habitat. Without repeated fires, for example, browse vigor and nutrient content has diminished (Freedman and Habeck 1985), and

many shrubs have grown beyond the reach of browsing animals. However, recent application of prescribed fire in the Camp Creek drainage appears to be an effective attempt to regenerate that component of the ecosystem. For example, field observations during the 1999 sampling season revealed much fire-induced sprouting of important browse species, such as bitterbrush, upland willow, and Idaho fescue.

Effects of fire exclusion on anadromous fish habitat are uncertain, but probably are trending negatively. For example, unnaturally severe fires occurring on the area's inherently unstable soils likely will promote greater than normal erosion and sedimentation into spawning beds. For example, many riparian zones previously under the nonlethal and mixed severity (i.e., MS_I and MS_II) fire regimes, have experienced substantial infilling by trees without recurrent thinning fires. Consequently, total stand replacement likely will occur at some future point, in riparian zones not already burned by recent wildfires.

Similarly, on upland sites in the montane zone, fire exclusion's effects are more readily apparent on productive ponderosa pine stands on northerly aspects. These frequently burned stands (i.e., MS_I regime) were also dominated by widely spaced, fire-resistant ponderosa pines, interspersed with moderately dense patches of western larch and Douglas-fir. However, long-term fire exclusion on these sites has promoted canopy closure and increasingly heavy dominance by shade tolerant species such as Douglas-fir and grand fir. Many unharvested stands are now highly decadent due to overstocking, mistletoe infections, and bark beetle attacks. Root rot pockets and heavy downfalls are also common in these mixed conifer stands. Consequently, downed fuels combined with thickets of understory ladder fuels have also promoted a shift in fire potential, from mixed severity- to stand replacement fires (Agee 1993).

Ponderosa pines in the study area often likely regenerated after fires during warm-dry climatic periods (Karl and Koscielny 1982, Graumlich 1987, Meko et al. 1993, Barrett et al. 1997). Conversely, even-age larch- or lodgepole pine age classes often became established after relatively severe fires in the early- to mid-1800s, during the height of the cool-moist Little Ice Age. Despite a subsequent return to a warm-dry climate, few ponderosa pines have regenerated on productive sites in the grand fir series during the last 100 years. Dense regeneration occurred on some north-facing slopes after fires in the late 1800s and early 1900s, followed by effective fire exclusion throughout most of the 20th Century. Many such stands are now heavily overcrowded and some have succumbed to bark beetles — due in part to a lack of thinning fires after initial establishment.

The effects of fire exclusion have been more variable in the upper elevational limits of the montane mixed conifer forest, and in the lower subalpine forest zone, such as in the larch-lodgepole pine-Douglas-fir and lodgepole pine cover types (i.e., MS_II regime). Most stands are still experiencing natural succession, but the data suggest that some current fire intervals are near the upper end of the HRV for the MS_II fire regime type—that is, substantially longer than the historical 60-year-long MFI.

In the upper subalpine zones, the SR and MS_III fire regime types are still evidently on natural cycles by virtue of long historical fire intervals. Also note that the fire frequency estimates for MS_III type stands probably are conservative, for several reasons. First, sampling tends to be biased toward those sites that happen to have fire scarred trees and/or readily identifiable fire regenerated age classes (e.g., lodgepole pine classes). Other sites, for example, those dominated by 1000-year-old whitebark pines, may have gone hundreds of years between fires and such sites

are usually not represented in the data because precisely estimating such intervals is infeasible. Because of these biases, the overall estimate of 198 years for MS_III stands may be conservative. For planning purposes, however, the data suggest that most stands within this fire regime type are still largely on a natural successional cycle, and that future wildfires will continue to produce positive ecological benefits.

Regardless of fire regime type, most stands in the subalpine forest zone are still experiencing natural succession because the historical fire intervals are usually longer than the fire exclusion period to date (and because recent fires have continued the natural fire cycle in this regime type). Nonetheless, many mid- to upper elevation stands contain substantial fuel loads—often adjacent to the impacted montane forest zone. Consequently, the South Fork drainage, and other drainages within central Idaho, apparently have been experiencing wildfires of unprecedented size and severity, when compared with the presettlement patterns. This scenario will likely continue because aggressive fire suppression undoubtedly will continue to eliminate all but the most severe fires in the area (i.e., during worse than "average bad" conditions).

Fire Regimes Modeling. The author's proposed fire regimes classification for the Northern Rockies has been cited throughout this report. For ease of reference, this system is described below.

1) *Nonlethal (NL) regime*. This fire regime consists of short interval (e.g., 10-20 yr MFI) low severity fires that kill less than 10 percent of the mature trees in a stand, often in a relatively uniform spread pattern (i.e., same as ICBMP definition [Morgan et al. 1998]). In the South Fork sampling, the 13-stand average MFI for stands in the nonlethal regime was just 12 years long.

Example: Xeric ponderosa pine stands on ponderosa pine- and dry Douglas-fir habitat types.

2) *Mixed Severity I (MS_I)* is a variant of the NL regime, but with longer intervals (e.g., 20-40 yr MFI) and somewhat more severe fires; stands are generally uneven-aged but often contain from one to four seral age classes that became initiated after mixed severity "hot spots" (e.g., on average, lethal severity perhaps affects only 20-30% of the stand); fire spread pattern is relatively uniform but probably more patchy than NL. In the South Fork sampling, the average MFI for stands in the MS_I regime was 22 years long—substantially shorter than in more northerly forests of the Northern Rockies.

Examples: Mesic ponderosa pine/Douglas-fir/western larch stands; relatively dry lodgepole pine dominated stands, especially when near Indian-burned terrain.

3) *Mixed Severity II (MS_II) regime* generally has more-severe fires than in MS_I, and is essentially a variant of the stand replacement fire regime (described below); fires occur after moderately long intervals (e.g., 50-100 yr MFI); stands generally are even-aged and are usually dominated by just one or two seral cohorts (e.g., mortality ranging from 30-80% of stand); fire spread pattern ranging from extremely patchy to relatively uniform. In the South Fork sampling, the 15-stand average MFI was 63 years long.

Examples: western larch/Douglas-fir stands and larch/lodgepole pine stands in the montane- and lower subalpine zones.

4) *Stand Replacement (SR) regime*. This regime represents moderately long interval (e.g., 100-200 yr MFI) stand replacing fires that kill >90% of stand; often relatively uniform spread pattern (i.e., similar to ICBMP definition [Morgan et al. 1998]). In the South Fork sampling, the 25-stand average MAFI was 170 years long.

Examples: Cold-moist subalpine stands dominated by pine and/or spruce-fir.

6) *Mixed Severity III (MS_III)* is a high elevation (i.e., upper treeline) fire regime displaying extreme variation in fire severity, interval length, and spread pattern. However, fire frequency trends toward moderately long- to long intervals [e.g., >150 yr MFI]). In the South Fork sampling, for example, the 6-stand average MAFI was 198 years long.

Examples: Whitebark pine dominated stands.

A preliminary fire regimes map prepared in 1999 by Forestry Technician B. Sanders (Payette National Forest) suggests that the modeling parameters extrapolated from the 1999 Salmon River Canyon Project fit relatively well for the South Fork drainage. However, that modeling effort did not include the high elevation MS_III fire regime type, due to a lack of data (and because that type does not occur in the SRCP analysis area). Adjustment of the model for that fire regime type would be comparatively straightforward, however. That fire regime type occupies a narrow strip of forest along upper treeline, largely in the whitebark pine habitat types.

Results from the preliminary modeling suggest that the NL, MS_I, and MS_II fire regime types predominate in the South Fork drainage, and likely throughout most of the Salmon River drainage. Specifically, the nonlethal fire regime occupies an estimated 15 percent of the forested terrain, while the ecologically similar MS_I regime occupies about 17 percent. Together, therefore, these two low severity/high frequency fire regime types occupy about one-third of the forested terrain in the South Fork.

Results from the preliminary model suggest that the remaining two-thirds of the South Fork's forested terrain occurs in the relatively high severity fire regime types (i.e., MS_II, SR).

However, these regimes differ substantially in terms of fire frequency. The moderately low frequency (60-yr MFI) MS_II fire regime apparently predominates among all fire regime types, occupying an estimated 55 percent of the forested terrain. Conversely, the low frequency (i.e., 170-yr MFI) SR fire regime occupies just 13 percent of the forested terrain, largely on steep north slopes.

Although the high elevation MS_III regime was not previously modeled, acreage for that type likely occurs in terrain modeled as MS_II. That is, both fire regimes occupy relatively open (i.e., lightly stocked) terrain, and are usually juxtaposed on the landscape. However, a recent modeling effort for the entire Northern Rockies region (Barrett 2000) suggests that the MS_III regime probably occupies less than 3 percent of the forested terrain.

The SR fire regime, which apparently is a relatively minor fire regime type throughout central Idaho, was somewhat more common in the middle- to northern end of the South Fork drainage and adjacent areas. Specifically, SR stands were more prevalent in the upper Secesh- and upper North Fork Payette River basins. This pattern may be partly a result of the more gently rolling terrain (i.e., less steep and less dissected topography) than in the steeper and more highly dissected mountains east of McCall. Although the generally steeper and higher elevation topography between Lick Creek Summit and Blackmare Summit presumably intercepts more precipitation than in the northern and southern ends of the South Fork, the fuels in the former area are more varied and discontinuous because of thinner soils and more widespread rocklands. These factors apparently promote the predominance of mixed severity fires (i.e., MS_II and MS_III fire regimes), as opposed to stand replacing fires in the more gently rolling and more continuously forested lodgepole pine dominated terrain in the northern portion of the South Fork

drainage. The southern portion of the drainage, although similar to the northern portion in terms of biophysical factors, apparently is more prone to mixed severity fires than to stand replacing fires. Reasons for this are unclear, but locally varying climatic patterns (e.g., storm tracks) could be a potential factor in the differing fire regimes patterns.

Implications for Management. Fire history research can be useful for planning ecologically-based forest management (Arno and Brown 1989, Mutch et al. 1993, Brown et al. 1994, Mutch 1994). For forest restoration, for example, managers can use the fire regimes information to identify and prioritize areas that might benefit from application of prescribed fire and fuels management silviculture. Specifically, the data from sample stands and the overall fire regimes model suggest which stands have been the most heavily affected by fire exclusion, versus areas still experiencing natural succession.

Fire history data can be used in designing management activities that simulate past fire disturbance. For example, thinning harvests would be appropriate restoration treatment for stands in the nonlethal and mixed severity fire regime, and prescriptions could vary by forest type. Uneven-age systems, or prescribed fires, would be appropriate for dry stands in the ponderosa pine-Douglas-fir cover type. Prescriptions could incorporate an initial light- to moderate thinning of understory poles, followed by individual-tree selection during future entries (Arno et al. 1995). Post-restoration entries could be scheduled to replicate the past range of fire intervals (e.g., 10-30 yr). Conversely, prescribed fire alone might be sufficient for restoring a semblance of natural succession on lightly stocked sites, such as in the dry ponderosa pine habitat types. In terms of maintenance burning, few lower elevation sites are still in balance with respect to the natural fire cycle. Nonetheless, manager-ignited prescribed fires would help diversify the age class mosaic,

particularly in the mixed conifer- and subalpine cover types.

For mixed conifer stands with currently long fire intervals, such as in the larch-Douglas-fir cover type, an initial moderate- to heavy thinning of understory poles might help restore historical stand structures. To simulate low- to moderate severity fires, subsequent harvests could use various combinations of uneven and even age systems, depending on site type and stand variability. For instance, individual tree- and small group selection would replicate the effects of mixed severity fires on sites dominated by larch and Douglas-fir. Moreover, long-term prescriptions could incorporate silvicultural or prescribed fire re-entries to simulate the range of past fire intervals (e.g., 25-100 yr). Alternatively, where silvicultural activities are not an option, manager ignited prescribed fires during non-severe fire weather (e.g., late fall) might help restore the previous mix of age classes in these forest types.

For landscape-scale planning, area fire cycles (Romme 1980) can help guide in scheduling and monitoring cumulative disturbance over time (fig. 20). Specifically, fire cycles can be calculated for each fire regime type by dividing the total acreage in a given type by the representative stand MFI. In the nonlethal fire regime, for example, dividing the total acreage in the model by the historical MFI (e.g., 12 yr) yields an estimate for the average number of acres burned per year during the historical period. Such modeling exercises can thus provide managers with useful information for monitoring the amount and locations of vegetation disturbance over time, whether from prescribed burning, wildfire, or fuels management silviculture. For example, recent prescribed burning in low elevation ponderosa pine stands appears to have good potential for successfully restoring low-severity fire regimes, and might help mitigate against impacts from inevitable high severity fires in the future.

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APPENDIX A.: Camp Creek Master Fire Chronology
(*Year & No. of plots per 56*)

20th Century	19th Century	18th Century	17th Century	16th/15th Centuries
1992: 6	1899: 18	1799: 11	1696: 5	1597: 2
'88 RX: 11	'89: 26	'97: 7	'88: 5	'92: 1
'81: 1	'82: 25	'94: 5	'77: 4	'85: 1
'56: 1	'78: 2	'85: 20	'62: 7	'64: 4
'48: 9	'75: 1	'83: 2	'58: 3	'54: 1
'40: 11	'70: 9	'80: 8	'54: 3	'48: 1
'32: 1	'66: 23	'71: 5	'48: 3	'21: 2
'26: 1	'61: 3	'67: 2	'42: 2	1497: 1
'18: 24	'59: 7	'64: 2	'37: 1	'71: 1
'13: 3	'57: 7	'60: 11	'34: 2	
'07: 1	'55: 5	'56: 4	'23: 3	
	'50: 8	'51: 3	'11: 1	
	'46: 5	'47: 5	'04: 1	
	'42: 15	'45: 6		
	'36: 2	'38: 6		
	'30: 25	'33: 1		
	'24: 5	'30: 3		
	'18: 5	'26: 3		
	'14: 13	'20: 2		
	'07: 8	'18: 3		
		'09: 5		

Master Fire Chronology: 1471-1948 (Natural Fire Period)
Number of Fires: 70
Fire Interval Range: 2-27 yr
Area Mean Fire Interval: 7 yr

APPENDIX B: Plot & Stand Location Data
(Note: The "stands" are used in Tables 1-5)

plot/STD	LATdeg	LATmin	LATsec	LONGdeg	LONGmin	LONGsec
01, CC23	44	53	789	115	38	31
02, CC24			840			207
03, CC25			986			277
04, CC14		54	821		39	720
05, CC15			803		42	381
06, CC2			512		40	495
07, CC1			38		42	592
08, CC1			397		41	855
09, CC5			115			350
10, CC5			25			285
11, CC5			297			603
12, CC30		55	369		36	637
13, CC31			40		37	252
14, CC31		54	984			25
15, CC31		55	229			28
16, CC32		54	831		36	713
17, CC33			578			720
18, CC34			437			756
19, CC34			203			446
20, CC35		53	739			685
21			181		37	519
22, CC22		52	655		38	318
23, CC29		55	452		37	282
24, CC28			27			421
25, CC26		54	490		38	719
26, CC27			320		38	281
27, CC16			457		38	868
28, CC16			320		41	106
29, CC17		53	407		42	518
30, CC3			609			228
31, CC3			616			170
32, CC3			682			219
33, CC3			645			82
34, CC3			869			25
35, CC4		54	41			31
36, CC4			82			183
37, CC9		53	258		41	592
38, CC7			532			525
39, CC7			589			285
40, CC7			716			153
41, CC6			960			72
42, CC6			749			327
43, CC6			787			621
44, CC8			249		42	253
45, CC10			345		41	336
46, CC11			377		40	884

47, CC11				347			787
48, CC12				632			305
49, CC13				865			29
50, CC18			52	921			692
51, CC19				784			355
52, CC20				856		39	584
53, CC21				727		38	795
54, CC36			55	69		40	19
55, CC36			55	50		38	281
56, CC37			56	8		38	31

Y E A R
2000 :

SS1	45		11	18	115	57	741
JL1			13	351		56	22
ST1			14	572		45	439
BS1			14	504		36	548
LC1			2	619		55	414
HL1			3	882		55	171
HL2			4	593		54	301
LL1			4	742		54	757
DL1			4	729		55	734
ML1	44		58	422		54	944
BC1			37	512		47	855
CCR1			35	550		45	465
CCR2			35	500		45	460
MC1			32	516		41	285
WL1			38	725		35	121
DC1			43	233		41	657
BLS1			48	92		47	708
BLS2			48	546		47	698
BL1			52	176		57	131
BH1			51	572		53	880
BH2			52	78		54	180
BL2			52	61		56	44
SP1	45		4	865		47	341
NF1		5		146		48	377
NF2		5		79		48	297